

## ELECTRICALLY HEATED PIPE ASSEMBLY

Field of Invention

This invention relates to pipe and, more particularly, to electrically heated pipe.

Cross-Reference to Related Applications

5 This invention is a continuation-in-part of U. S. Application Serial No. 674,698 filed November 26, 1984, which is a division of U. S. Application Serial No. 295,000 filed August 21, 1981, which is a continuation-  
10 in-part of U. S. Application Serial No. 181,974 filed August 28, 1980, all of which are here incorporated by reference.

Background of Invention

15 There are a number of applications in which heated pipe is desirable or necessary. For example, it may be necessary to heat domestic, boat or recreational vehicle water pipes to prevent freezing. Similarly, many manufacturing procedures require that materials being  
20 processed be maintained at a specific temperature while they flow through pipe from one location to another or otherwise.

In the past, it has been difficult and expensive to provide satisfactory heating, especially with non-metallic pipes.

### Summary of the Invention

5           The present invention features a heated pipe assembly, particularly useful with plastic pipe, which comprises a pipe having a longitudinally-extending outer surface, a pair of conductors extending longitudinally of the outer surface generally parallel to and spaced  
10           from each other, an organic plastic sheet wrapped circumferentially around the outer surface of the pipe, and a semi-conductor pattern carried on a radially-facing surface of the sheet. The semi-conductor pattern comprises a plurality of generally axially-spaced semi-  
15           conductor stripes and, between adjacent strips, a portion of the plastic sheet that is free from the semi-conductor pattern. The stripes are on the same side of the sheet as the conductors, and each stripe is in electrical contact with both conductors.

20           In preferred embodiments in which the plastic sheet comprises a tape wrapped helically around the pipe, the semi-conductor pattern is on the radially-inner side of the organic plastic sheet, and an insulating layer is co-extruded over the tape. In embodiments in which the

pipe is flexible, the conductors comprise wire formed in a serpentine pattern.

### Drawings

Figure 1 is a perspective view, partially in section, of a heated pipe assembly embodying the present invention.

Figure 2 is a plan, partially diagrammatic, view of the pipe assembly of Figure 1, with the outer insulation layer removed and the heating layer partially broken away.

Figure 3 is a sectional view of a portion of the pipe assembly of Figure 1.

Figure 4 is a sectional view of a system for connecting pipe assemblies of the present invention.

Figure 5 is a sectional view of a modified pipe used in the pipe assembly of the present invention.

Figure 6 is a perspective view, partially in section, of a conductor retainer for use in pipe assemblies of the present invention.

Figure 7 is a perspective view of a modified pipe assembly embodying the present invention.

Description of Preferred Embodiments

Referring now to Figure 1 through 3 there is shown a heated pipe assembly, generally designated 10, comprising a cylindrical plastic (CPVC) pipe 12, a heating layer 14 including an elongated electrical heating tape 15 helically wrapped tightly around the exterior cylindrical surface of pipe 12, and a cylindrical, organic plastic, insulating sleeve 16 shrink-fitted (e.g., a PVC tape helically wrapped around tape 14 and then heat-treated to shrink it tightly into place, or a PVC tube slipped over the tape layer and then similarly heat-shrunked) around or, preferably, co-extruded over, the exterior of heating layer 14. A pair of flat copper strip electrodes 18 [about 1/2 inch (1.3 cm.) wide and 0.003 inch (0.076 mm.)] thick are mounted in shallow recesses 20 in the exterior cylindrical surface of pipe 12. As shown, electrodes 18 are diametrically spaced from each other and extend, parallel to each other and to the axis of pipe 10, along the length of the pipe. The relative thickness of the electrodes 18 and depth (measured radially) of recesses 20 are such that the electrodes 18 extend radially beyond the pipe outer surface and are in tight face-to-face engagement with heating layer 14.

The tape 15 of heating layer 14 is a one inch (2.5 cm.) wide, 0.004 inch (0.10 mm.) thick strip 22 of essentially transparent polyester ("Mylar") on one side of which has been printed a semi-conductor pattern (of the type disclosed in the cross-referenced prior applications) comprising two parallel semi-conductor stripes 24 [each  $5/8$  inch (1.6 cm.) wide] separated by a central area 26 [ $3/8$  inch (1 cm.) wide] which is free from semi-conductor material. The semi-conductor pattern is much thinner than tape 15 and, accordingly, is not shown in the cross-sectional view of Fig. 3. Similar semi-conductor-free areas 28 [each  $3/16$  inch (0.5 cm.) wide] are provided along the two side edges of the tape 14. As shown most clearly in Figure 2, the tape 15 is wrapped helically around the exterior of pipe 12 with the side edges 30 of adjacent turns abutting each other. In the preferred embodiments, the tape is wrapped with the semi-conductor pattern facing radially inwardly, i.e., so that the semi-conductor stripes 24 engage the copper conductors 18. Because the plastic strip 22 is essentially transparent, the semi-conductor stripes 24 and semi-conductor areas 26, 28 are clearly visible in the drawings even though they are on the inside of the heating layer 14.

The system for connecting adjacent lengths of pipe and making the necessary electrical connections is shown in Figure 4. The ends of two pipes 10 are inserted into opposite ends of a sleeve 40, with the copper electrodes 18 of one pipe in axial alignment with the copper electrodes of the other, until the pipe ends about a circumferential flange 42 at the middle of the sleeve. Four electrical connecting pins 44 are screwed radially into the sleeve. Each pin passes through (and thus provides electrical contact with) one of the electrodes 18 of each pipe 10. The two pins 44 on each side of the sleeve 40 are connected to each other with a wire conductor 46. At the ends of the overall pipe, or at regular intervals if the overall pipe is of considerable length, the wires 46 are in turn connected to an electrical power source (not shown).

The construction of Figures 1-3 is particularly suited for rigid or relatively straight pipe; the flat copper strip electrodes 18 permit relatively little bending. For flexible pipe, such as is used in recreational vehicles, it is preferred to use an electrode 118 such as that shown in Figures 5 and 6. Electrode 118 is soft, tin-plated, 20 gauge [about 0.032 inch (0.08 cm.) diameter] bus wire bent into a

serpentine shape (as shown most clearly in Figure 6) so that the overall width of the electrode 118 is about 1/2 (1.2 cm.) inch. The recess 120 into which the electrode fits is about 0.025 inch (0.064 cm.) deep (i.e., as with the Figures 1-3 embodiment is slightly less deep than the overall thickness of the electrode), and is made a little less than 1/2 inch (1.27 cm.) wide with its side edges inclined slightly inwardly towards each other. Thus, as shown, the serpentine wire electrode 118 will snap into, and be retained in place in, the recess 120. The serpentine shape of the electrode 118 permits the electrode to increase or decrease in length, as required when the pipe is bent, without danger of breaking.

Figure 5 also shows, in cross-section, a flexible polybutylene pipe 112 which can be substituted for rigid CPVC pipe 12 in pipe assembly 10. As shown the outer surface 114 of pipe 112 is slightly elliptical, thus providing substantially the same wall thickness both in the portions of the pipe defining recesses 120 and in the rest of the pipe side wall.

Figure 6 shows an electrode retainer 200 that facilitates the use of the present invention with, for example, conventional cylindrical flexible pipe. Retainer 200 has a cylindrical inner surface 202 adapted

to fit tightly around the exterior surface of a conventional cylindrical pipe, and an elliptical outer surface 204 that provides, in the center of the retainer, sufficient thickness to permit a recess 206  
5 for a serpentine conductor 118. As will be evident, a pair of retainers 200 with conductors 118 therein may be

placed on opposite sides of a conventional cylindrical pipe, and the electrical heating tape 15 then wrapped around the entire assembly as in the Figures 1-3 embodiments.

5           In the above embodiment, the conductive graphite of semi-conductor pattern covers about 2/3 of the total surface area of the pipe and is designed to provide about 35 watts per linear foot. In other embodiments, the graphite coverage may be more or less, depending on  
10           the particular application, but usually should not be less than about 50 percent.

#### Other Embodiments

          Although the present invention is particularly suited to use with plastic pipe, it may be used with  
15           steel pipe also. When so used, either the outer surface of the steel pipe must be coated with an electrically insulating layer before the electric heating tape 15 is wrapped therearound, or the tape must be wrapped with the semi-conductor pattern facing outwardly (so that the  
20           substrate 22 will provide an insulating layer between the semi-conductor patten and the steel pipe) and with the copper conductors 18 between the tape 15 and the outer layer of insulation 16.

Figure 7 illustrates a pipe assembly, generally designated 210, including a plastic pipe 212 in which are embedded a pair of elongated parallel electrodes 222 at 180° with respect to each other. The semi-conductor pattern, which may be printed either directly on the pipe 212 (as shown) or on a polyester sheet which is wrapped around the pipe 212, comprises four axially-extending semi-conductor bars 214 and a plurality of semi-conductor stripes 218 spaced from each other and extending generally helically around the pipe. Semi-conductor free areas 220 are provided between adjacent stripes 218. As shown, two bars 214 are provided in electrical contact with each of conductors 222, and each stripe 218 extends (slightly less than 180°) from a bar 214 on one side of one of conductors 222 to the bar 214 on the same side of the other conductor 222.

Other embodiments will be within the scope of the following claims.

What is claimed is:

1. An electrically heated pipe assembly comprising:

a pipe having a longitudinally-extending, electrically-insulating outer surface;

5 a pair of conductors extending longitudinally of said pipe outer surface, said conductors being generally parallel to and spaced apart from each other;

an organic plastic sheet wrapped circumferentially around said pipe outer surface; and,

10 a semi-conductor pattern carried on a radially-facing surface of said plastic sheet, said pattern being arranged to provide a plurality of axially-spaced conductive stripes and, between adjacent ones of said stripes, a portion of said sheet that is free from said  
15 semi-conductor patter,

said stripes and said conductors being on the same radial side of said sheet and each of each stripes engaging both of said conductors.

2. The pipe assembly of claim 1 wherein said  
20 plastic sheet comprises a tape wrapped helically around said pipe outer surface.

3. The pipe assembly of claim 2 wherein said tape includes a plurality of semi-conductor stripes extending

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longitudinally of said tape parallel to and spaced apart from each other, a semi-conductor free area intermediate adjacent ones of said stripes, and a semi-conductor free area extending along each of the longitudinal side edges of said tape.

4. The pipe assembly of claim 1 wherein said stripes are on the radially-inward side of said sheet.

5. The pipe assembly of claim 4 wherein the exterior surface of said pipe defines a pair of longitudinally-extending recesses, one of said conductors being mounted in each of said recesses and the radial depth of each of said recesses being not greater than the thickness of a respective one of said conductors.

6. The pipe assembly of claim 1 wherein said conductor comprises a wire formed in a serpentine pattern to form a generally planar conductor having a width several times its thickness.

7. The pipe assembly of claim 6 wherein said pipe is flexible.

8. The pipe assembly of claim 1 including a generally cylindrical insulating layer defining the outer surface of said pipe assembly.

9. An electrically heated pipe assembly  
5 comprising:

a pipe having a longitudinally-extending,  
electrically insulating outer surface;

a pair of conductors extending longitudinally of  
said pipe, said conductors being generally parallel to  
10 and spaced apart from each other; and

a semi-conductor pattern engaging said outer-  
surface and said conductors, said pattern being arranged  
to provide a plurality of axially-spaced conductive  
stripes and, between adjacent ones of said stripes, an  
15 area that is free from said semi-conductor pattern.

said stripes and said conductors being on the same  
radial side of said sheet and each of each stripes  
engaging both of said conductors.

10. The pipe assembly of claim 9 wherein said  
20 semi-conductor pattern is carried on an organic plastic  
sheet wrapped circumferentially around said pipe outer  
surface.

11. An electrically heated pipe assembly comprising:

a pipe having a longitudinally-extending, electrically-insulating outer surface;

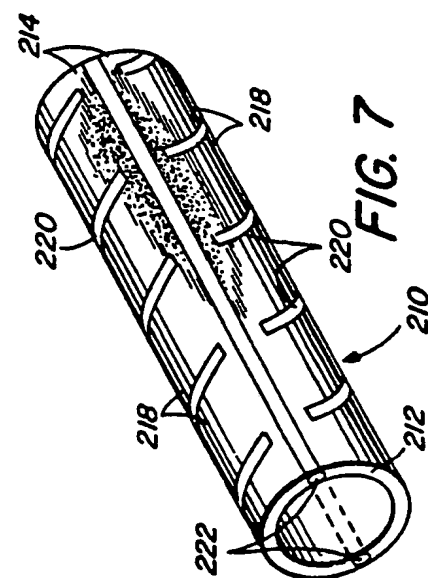
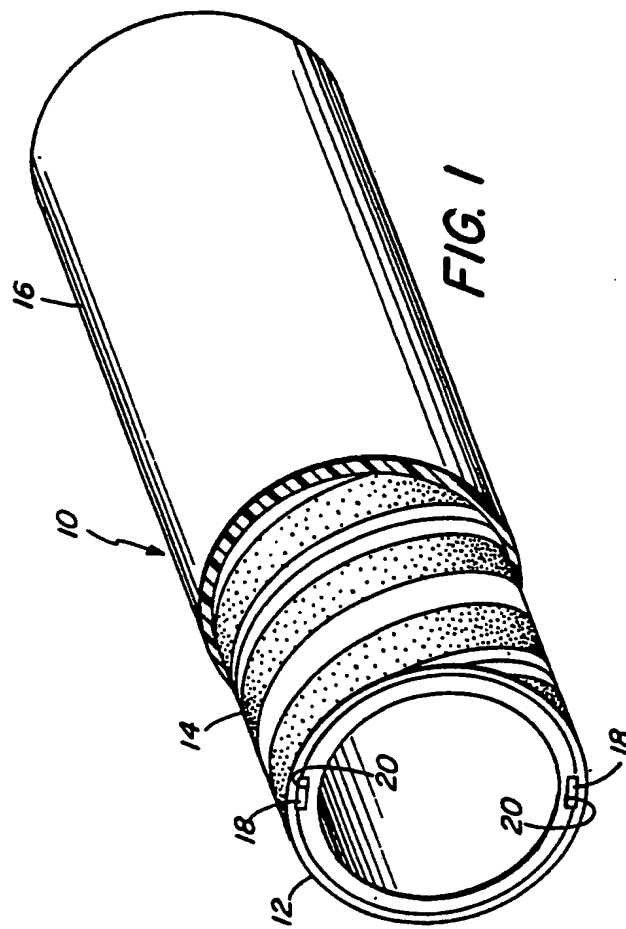
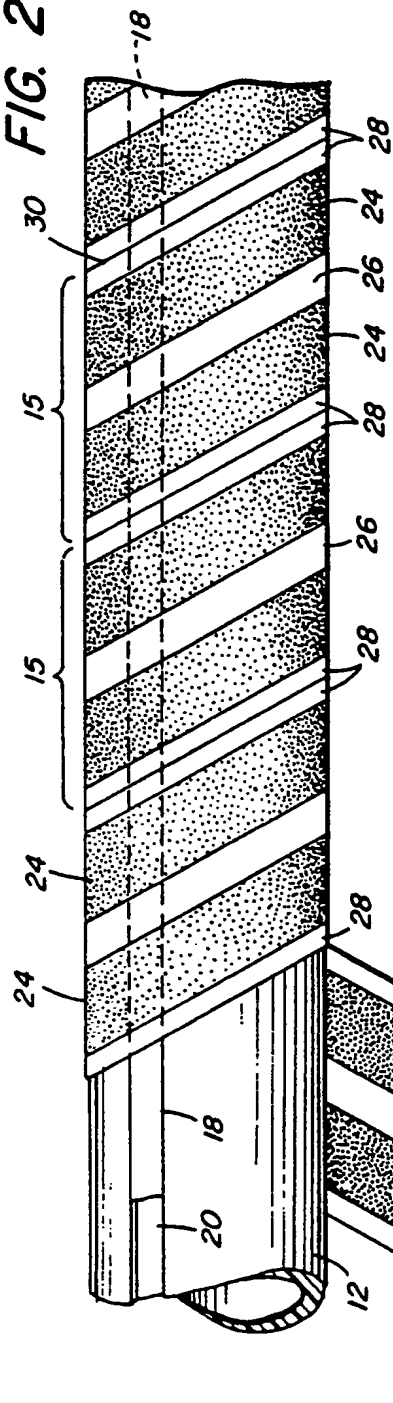
5 a pair of parallel conductors mounted on said outer surface on generally diametric opposite sides of said pipe;

an organic plastic tape wrapped helically around said pipe outer surface; and,

10 a semi-conductor pattern carried on the radially-inwardly facing surface of said tape, said pattern comprising a pair of parallel conductive stripes extending longitudinally of said tape and spaced apart from each other, a semi-conductor free area intermediate  
15 said stripes and a semi-conductor free area extending along each of the longitudinal side edges of said tape, whereby said stripes extend generally helically of said pipe and engage both of said conductors.

12. The pipe assembly of claim 11 including a  
20 generally cylindrical insulating layer surrounding said tape.

13. The pipe assembly of claim 12 wherein said insulating layer is heat-shrunk around said tape.



**SUBSTITUTE SHEET**

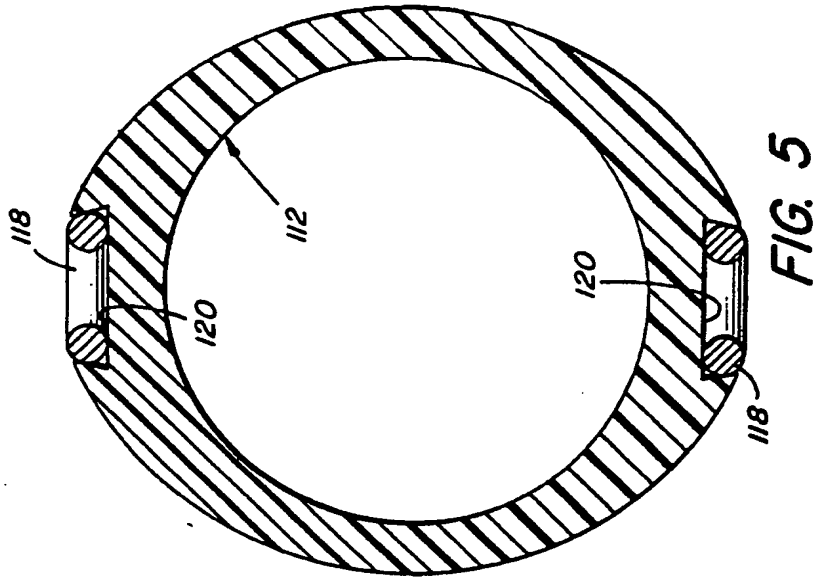


FIG. 5

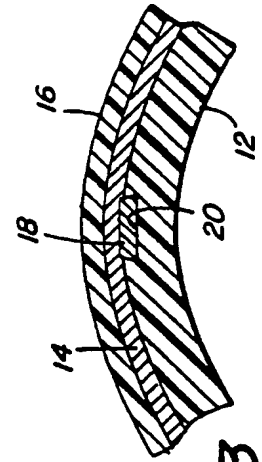


FIG. 3

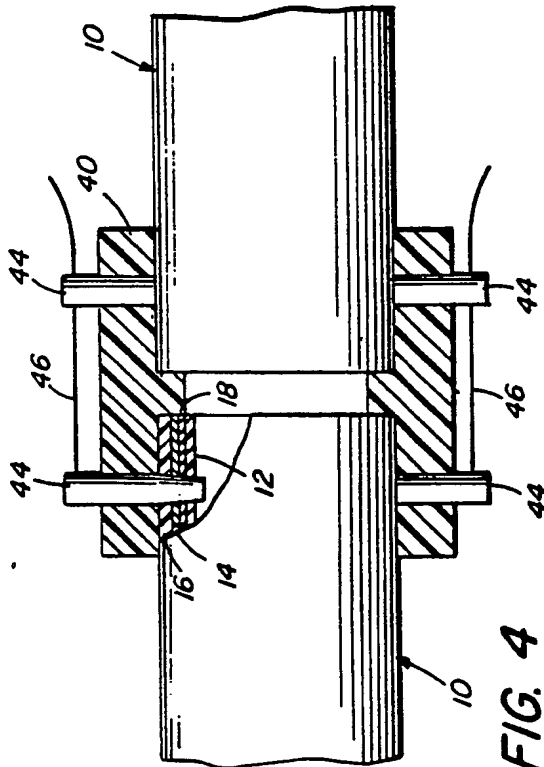


FIG. 4

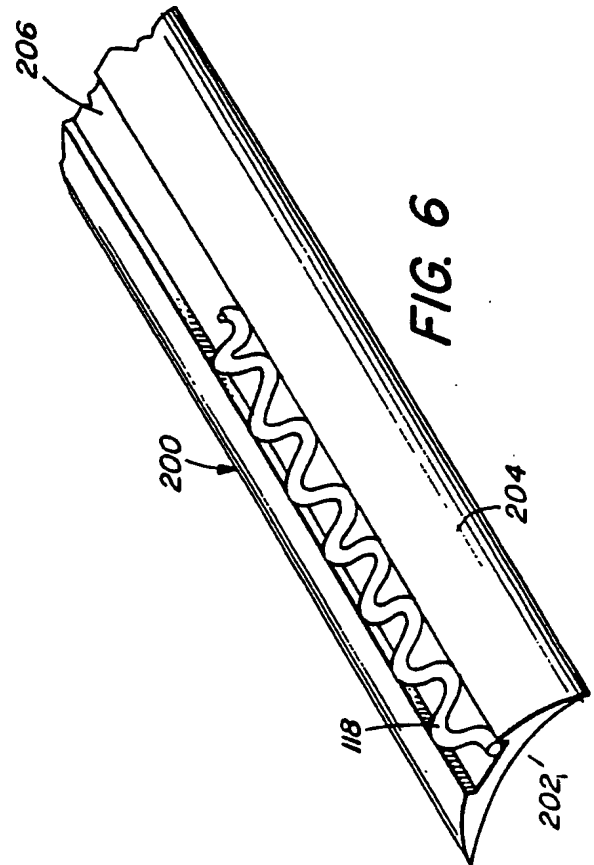


FIG. 6

# INTERNATIONAL SEARCH REPORT

International Application No PCT/US 85/02340

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>3</sup> According to International Patent Classification (IPC) or to both National Classification and IPC INT. CL. <sup>4</sup> - H05B 3/16; 3/58; F16L 53/00; F24H 1/12 U.S. CL. - 219/301,522,528,535,543,549; 138/33; 174/47																																			
<b>II. FIELDS SEARCHED</b> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 5px 0;">Minimum Documentation Searched <sup>4</sup></div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 20%; border-bottom: 1px solid black;">Classification System</th> <th style="border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">US</td> <td style="padding: 5px;">138/33 219/300,301,522,528,535,543,549 174 / 47</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black; margin: 5px 0;">Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>5</sup></div>			Classification System	Classification Symbols	US	138/33 219/300,301,522,528,535,543,549 174 / 47																													
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<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>14</sup> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%; border-bottom: 1px solid black;">Category <sup>6</sup></th> <th style="border-bottom: 1px solid black;">Citation of Document, <sup>16</sup> with Indication, where appropriate, of the relevant passages <sup>17</sup></th> <th style="width: 10%; border-bottom: 1px solid black;">Relevant to Claim No. <sup>18</sup></th> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">Y</td> <td style="padding: 5px;">US,A, 2,274,839, Published 03 March 1942, See Figs. 3 and 4, Marick.</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1,8,9</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">Y</td> <td style="padding: 5px;">US,A, 3,898,427, Published 05 August 1975, See Fig. 5, Levin et al.</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1,8,9</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">Y,P</td> <td style="padding: 5px;">US,A, 4,485,297, Published 27 November 1984, See Fig. 7, Grise et al.</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1,8,9</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">FR,A, 2,417,233, Published 07 September 1979, See Fig. 5.</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">Y</td> <td style="padding: 5px;">GB,A, 2,065,430, Published 24 June 1981, See Fig. 3.</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1,8,9</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">GB,A, 2,104,357, Published 02 March 1983, See Fig. 2.</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">US,A, 3,582,968, Published 01 June 1971, See Figs. 1-3, Buiting et al.</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">US,A, 4,484,061, Published 20 November 1984, See Fig. 3, Zelinka et al.</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">US,A, 2,719,907, Published 04 October 1955, See Figs. 2-4, Combs.</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> <tr> <td style="text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="padding: 5px;">US,A, 2,683,673, Published 13 July 1954, See Fig. 1, Silversher.</td> <td style="text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> </table>			Category <sup>6</sup>	Citation of Document, <sup>16</sup> with Indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>18</sup>	Y	US,A, 2,274,839, Published 03 March 1942, See Figs. 3 and 4, Marick.	1,8,9	Y	US,A, 3,898,427, Published 05 August 1975, See Fig. 5, Levin et al.	1,8,9	Y,P	US,A, 4,485,297, Published 27 November 1984, See Fig. 7, Grise et al.	1,8,9	A	FR,A, 2,417,233, Published 07 September 1979, See Fig. 5.	1	Y	GB,A, 2,065,430, Published 24 June 1981, See Fig. 3.	1,8,9	A	GB,A, 2,104,357, Published 02 March 1983, See Fig. 2.	1	A	US,A, 3,582,968, Published 01 June 1971, See Figs. 1-3, Buiting et al.	1	A	US,A, 4,484,061, Published 20 November 1984, See Fig. 3, Zelinka et al.	1	A	US,A, 2,719,907, Published 04 October 1955, See Figs. 2-4, Combs.	1	A	US,A, 2,683,673, Published 13 July 1954, See Fig. 1, Silversher.	1
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<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><sup>15</sup> Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p> </div> </div>																																			
<b>IV. CERTIFICATION</b> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;">Date of the Actual Completion of the International Search <sup>1</sup></td> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;">Date of Mailing of this International Search Report <sup>2</sup></td> </tr> <tr> <td style="text-align: center; padding: 5px;">02 FEBRUARY 1986</td> <td style="text-align: center; padding: 5px;">13 FEB 1986</td> </tr> <tr> <td style="border-bottom: 1px solid black; padding: 5px;">International Searching Authority <sup>1</sup></td> <td style="border-bottom: 1px solid black; padding: 5px;">Signature of Authorized Officer <sup>20</sup></td> </tr> <tr> <td style="text-align: center; padding: 5px;">ISA/US</td> <td style="text-align: center; padding: 5px;">A. Bartis </td> </tr> </table>			Date of the Actual Completion of the International Search <sup>1</sup>	Date of Mailing of this International Search Report <sup>2</sup>	02 FEBRUARY 1986	13 FEB 1986	International Searching Authority <sup>1</sup>	Signature of Authorized Officer <sup>20</sup>	ISA/US	A. Bartis																									
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